

| • Write balanced nuclear equations for the following changes. | <b>Marks</b><br><b>4</b> |
|---|--------------------------|
| Electron capture by $^{37}\text{Ar}$                          |                          |
| Positron emission by $^{93}\text{Ru}$                         |                          |
| Beta particle emission by $^{42}\text{K}$                     |                          |
| Alpha particle emission by $^{251}\text{Cf}$                  |                          |

- Balance the following nuclear reactions and name the decay process occurring.

**Marks  
6**

| Equation   | Name of decay process |
|--|-----------------------|
| ${}^{15}_8\text{O} \rightarrow {}^{15}_7\text{N} + \square$          |                       |
| ${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + \square$ |                       |
| ${}^{40}_{19}\text{K} + \square \rightarrow {}^{40}_{18}\text{Ar}$   |                       |

|  |                          |
|--|--------------------------|
| <ul style="list-style-type: none"><li>What mass of isotope would be initially required if a medical procedure needs 2.0 mg of <math>^{99m}\text{Tc}</math> exactly 50 hours later? The half life of <math>^{99m}\text{Tc}</math> is 6.0 hours.</li></ul> | <b>Marks</b><br><b>2</b> |
|  |                          |
|  |                          |
| <ul style="list-style-type: none"><li>Comment on the stability of the following nuclides, and the type of radioactive decay (if any) that they undergo.</li></ul>  | <b>3</b>                 |
| $^{18}_{10}\text{Ne}$  |                          |
| $^{32}_{16}\text{S}$   |                          |
| $^{236}_{90}\text{Th}$   |                          |

|   |                          |
|---|--------------------------|
| <ul style="list-style-type: none"><li>The <math>^{14}\text{C}</math> specific activity of a tooth found in an archaeological dig is 0.34 Bq. The <math>^{14}\text{C}</math> specific activity in living organisms is 15.3 Bq. How old is the tooth?</li></ul> | <b>Marks</b><br><b>4</b> |
|   |                          |
| <b>Answer:</b>  |                          |
| <p>Give two reasons why the accuracy of radiocarbon dating is more uncertain for older objects.</p>   |                          |
|   |                          |
| <ul style="list-style-type: none"><li>Why are positron emitters the best type of radioisotope to use for tomography?</li></ul>  | <b>2</b>                 |
|   |                          |

| • Explain the following terms or concepts. | <b>Marks</b><br><b>3</b> |
|--|--------------------------|
| a) Lipid bilayer                           |                          |
| b) Oxidation number                        |                          |
| c) Electrolysis                            |                          |

- Write balanced nuclear equations for the following reactions.

2

Beta decay of nickel-66.

Electron capture of selenium-72

|  |                          |
|--|--------------------------|
| <ul style="list-style-type: none"><li>A medical procedure requires 15.0 mg of <math>^{111}\text{In}</math>. What mass of isotope would be required to be able to use it exactly 4 days later? The half life of <math>^{111}\text{In}</math> is 2.80 days.</li></ul> <div data-bbox="130 257 1316 526" style="border: 1px solid black; height: 120px;"></div> <div data-bbox="726 526 1316 600" style="border: 1px solid black; padding: 5px;">Answer:</div>  | <b>Marks</b><br><b>2</b> |
| <ul style="list-style-type: none"><li>Write balanced nuclear equations for the following reactions.<br/>Positron decay of potassium-40.</li></ul> <div data-bbox="130 721 1316 817" style="border: 1px solid black; height: 43px;"></div> <p>Electron capture by gallium-67.</p> <div data-bbox="130 884 1316 963" style="border: 1px solid black; height: 35px;"></div> <p>Alpha decay of dysprosium-151.</p> <div data-bbox="130 1030 1316 1108" style="border: 1px solid black; height: 35px;"></div> | <b>3</b>                 |
| <ul style="list-style-type: none"><li>Briefly explain the apparent contradiction between the following statements.<br/>“Alpha particles are easily stopped by the skin.”<br/>“The alpha-emitter, radon, is thought to be a significant cause of cancer.”</li></ul> <div data-bbox="130 1265 1316 1440" style="border: 1px solid black; height: 78px;"></div>   | <b>1</b>                 |

**Marks**  
**3**

- Strontium-90 is one of the harmful nuclides resulting from nuclear fission explosions. Strontium-90 decays by beta particle emission with a half-life of 28.0 years. How long (in years) would it take for 99.0% of a sample of strontium-90 released in an atmospheric test of an atomic bomb to decay?

Answer:



**Marks**  
**7**

- A cyclotron facility can produce beams of neutrons or protons. Theoretically,  $^{188}_{75}\text{Re}$  can be produced by irradiation of  $^{186}_{74}\text{W}$  with either particle followed by radioactive decay of the intermediate nuclide. Give the relevant equations to describe both sequences of reactions.

neutron bombardment

proton bombardment

In practice, only the sequence using neutron bombardment is used. Give one possible reason why proton bombardment is not used.

Rhenium-188 is used for the relief of cancer-induced bone pain and has a half life of 16.7 hours. What mass of  $^{188}_{75}\text{Re}$  needs to be produced to allow shipment 24 hours later of a solution with a specific activity of 500 mCi?

Answer:

- If a medical procedure calls for 2.0 mg of  $^{48}\text{V}$ , what mass of isotope would be required to be able to use it exactly one week later? The half life of  $^{48}\text{V}$  is 1.61 days.

**Marks**  
**2**

Answer:

- If a medical procedure calls for 1.0 mg of  $^{128}\text{Ba}$ , how much isotope would be required to be able to use it exactly one week later? The half life of  $^{128}\text{Ba}$  is 2.43 days.

**Marks**  
**2**

Answer:

- A watch contains a radioactive substance with a decay constant of  $1.40 \times 10^{-2} \text{ year}^{-1}$ . After 50 years 25 mg of the radioactive material remains. Calculate the amount originally present.

**Marks**  
**2**

Answer:

- Briefly explain why a radionuclide used in diagnostic work should have a short half-life.

**2**

- Briefly explain why alpha emitters are not used in diagnostic work.

**2**